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Genetic Study of Dairy Cattle and Buffalo Bulls Based on Growth, Milk Production and Reproductive Traits

Research Article

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ABSTRACT

The present investigation aimed to conduct a genetic study of dairy cattle and buffalo bulls based on economic traits and their phenotypic correlation. The means of various economic traits in both the species are presented. Cattle bulls reported a better libido score, Flehmen response, requirement of mounting stimulus and semen volume, conception rate and expected predicted difference for milk production. Significant differences were observed between cattle and buffalo in growth traits (birth weight, 3 months body weight, 6 months body weight), reproduction traits (individual semen motility, post thaw semen motility and requirement of mounting stimulus). Association studies conducted among various growth, reproduction and production traits revealed that, a positively high and significant association existed among growth traits and individual motility with the number of semen doses per collection in crossbred bulls. Three month body weight was associated significantly with expected predicted difference ($P<0.05$) in crossbred bulls. However in the case of Murrah bulls, a significantly high correlation was observed among body weights at birth and at three months of age.

KEY WORDS economic traits, expected predicted difference, growth traits, libido score, phenotypic correlation.

INTRODUCTION

In India, there are currently 26 and 8 recognized breeds of indigenous cattle and riverine buffaloes, respectively. The total population of cattle and buffaloes was estimated to be 185.18 and 97.92 million in 2003 (Livestock Census, 2003), of which the indigenous and crossbred cattle represented 160.49 and 24.68 million animals respectively. It has been found that the annual growth rate of indigenous crossbred cattle and buffaloes had increased marginally, however, the growth rate for buffaloes was found to be the highest. India has achieved the distinction of being the world's top milk producing country, with an estimated output of 97.1 MT in 2005-2006 with a per-capita availability of milk of 241 gm/d. Milk production was estimated as 19.34 MT, 20.41 MT and 52.07 MT, respectively, in crossbred cows, non-descript cows and buffaloes in 2005-2006. Average milk yield in kg per year has been reported to be 1800, 900 and 1200 for crossbred and indigenous cattle and buffalo, respectively. Average per animal productivity has been observed to be 987 kg per lactation in India compared to 2038 kg per lactation in the world (Livestock Census, 2003).

Artificial insemination was adopted on the organized farm because it was thought initially that "sire is half of the herd" in the progeny testing program. However, considering the importance of sire selection in the herd, research has shown that the total genetic gain obtained through sire-to-sire path and sire to dam path is about 64 percent, equating to more than a 50 percent contribution (Basu, 1985). The

increased genetic gain through sire over dam is due to the greater intensity of selection that can be applied amongst male parents, thus the greater accuracy for estimating the breeding value of sires and the production of a larger number of daughters which make contributions as replacement stock for the next generation (Basu, 1985; Jain, 1992).

The importance of male animals in selection emphasizes a set of existing criteria for selection of young male animals under the breeding program. The young males initially are screened based on their expected predicted difference (EPD), percent superiority over the herd average, breed characteristics and theirdam's best lactation 305-day yield. Breeding values should be more than the target values and the young males should be the sons of proven sires (Anonymous, 2009).

After attaining maturity, young bulls are screened based on their growth and physical conformity, sexual behaviour, semen characteristics including semen freezability and microbial load of the semen, and the test bulls should be free from deadly diseases as tuberculosis, jones disease and infectious bovine rhinotracheitis, brucellosis and must be vaccinated against haemorrhagic septicaemia, black quarters and foot and mouth disease (Anonymous, 2009).

For any improvement in a herd, selection is a major tool for a breeder. The selection used conventionally that is based on the phenotypic traits is time consuming and also lacks accuracy. Multitrait selection can be employed for overall improvement and improved economic returns. It becomes a tedious job to select the traits under consideration. In this connection phenotypic correlation among the various traits such as growth, reproduction and production is to be taken into consideration for the overall improvement, which can give us maximum economic return.

The greater the number of traits considered, the more the selection process becomes difficult. After studying the phenotypic correlation of the traits, a number of traits can be minimized by excluding one trait when more than one trait has a high phenotypic correlation. Hence the present study was conducted to examine the economically important traits of dairy cattle and buffalo and the phenotypic correlation among various growth, production and reproduction traits.

MATERIALS AND METHODS

Animals: The present study was conducted with 52 crossbred cattle (Holstein Friesian crossed with Tharparkar) and 50 Murrah buffalo bulls maintained at the Artificial Breeding Complex of the National Dairy Research Institute, Karnal, Haryana, India.

Sample and data: Data on various economic traits including growth, production and reproduction on dairy bulls were generated as well as collected. The duration of the study was 4 months. The study of semen characteristics and behavioural characteristics for various bulls studied were conducted in a particular season.

The male animals were selected randomly and were kept individually under a loose housing system. The semen was collected 8.30 to 9.30 a.m. from February to March and 7.30 to 8.30 a.m. from April to May. The ejaculates were collected twice weekly and behavioral traits including libido score, reaction time, Flehmen's response and requirement of mounting stimulus were noted during daily semen collection and evaluation.

Various semen traits (semen volume, sperm mass activity, semen consistency and individual fresh sperm motility and post thaw sperm motility) were estimated immediately after daily semen collection. For all practical purposes semen was frozen when the mass activity was more than 3.5 and the lower standard for sperm concentration remained (20×10^6 motile sperm per semen dose).

libido is the willingness and eagerness of a male animal to mount and to attempt service on the female and mating ability is the ability to complete a service when an opportunity is provided (Chenoweth, 1981; Sharma *et al*. 2003). A Libido score card was prepared and libido was scored on a 10-point scale (Chenoweth, 1981) (Table 1).

Reaction time was measured as the time taken by a bull from its introduction to female (or a trained bull i.e. dummy in case of the present study) until first ejaculation Flehmen's response wascharacterized as when the bull stands rigidly and holds his head in horizontal position, which the bull may move slowly from side to side with his neck extended and upper lip raised.

Flehmen's response facilitates olfactory and vomeronasal organ access to body secretions, which allow the male to identify female reproductive status. The passive partner does not object to this procedure. Flehmen's response generally lasts for 10 to 30 sec. The bulls exhibiting Flehmen's response were coded as 1 and when no response was obtained 2.

Bulls will usually mount a female or a dummy with no encouragement, however some bulls are reluctant to mount and an external stimulus (e.g. whistling sound) is needed. When an external stimulus was required for mounting by a bull, the code was 1 and when no stimulus was needed this was coded as 2.

Statistical analysis: Mean and standard error of the traits were calculated using standard statistical procedure (Snedecor and Cochran, 1967).

The expected predicted differences (EPD) of the bulls were collected from the records maintained. EPD is calculated based on the record of the average milk yield of dam and paternal grand dam, and is calculated (Jain, 1992) as follows:

$EPD = ½ h^2 M_1 (M-\mu) + ¼ h^2 P_1 (P-\mu)$
Where,
$M_1 = n / [1 + (n-1) r]$
n= no of lactation
r= repeatability
M= average lactation yield of dams
μ= population average

$P_1 = p / [1 + (p–1) r]$
p= number of lactations of paternal grand dam
P= average lactation yield of paternal grand dam

Percent superiority is estimated based on genetic superiority above the herd average in percent.

To compare the economic traits a series of t-tests were used. The phenotypic correlations (r_p) between the records of two traits were estimated by using the following formula:

$$r_{p(xy)} = [\sigma_{s(xy)} + \sigma_{e(xy)}] / \sqrt{[\{\sigma^2_{s(x)} + \sigma^2_{e(x)}\} \times \{\sigma^2_{s(y)} + \sigma^2_{e(y)}\}]}$$

The standard errors of phenotypic correlation were obtained by using the following formula:

$$SE(r_{p(xy)}) = \sqrt{[(1-r_p^2) / (n-2)]}$$

The significance of phenotypic correlations was adjudged after estimating the t-values and comparing them with table values at (n-2) df as given by Snedecor and Cochran (1967).

$$t = r_p \sqrt{(n-2) / (1-r^2_p)}$$

RESULTS AND DISCUSSION

I. Various phenotypic traits

A. Growth traits

The mean with standard error of various growth characteristics under investigation for crossbred bulls and Murrah bulls is presented in (Table 2).

Body weight

The mean birth weight of crossbred bulls was observed as 28.83±0.56 kg (Table 2). Biswas *et al.* (2003) also found lower birth weight in male crossbred Holstein, Jersey and the Sahiwal bulls.

Birth weight of buffalo calves (33.83±0.45 kg) was significantly (P<0.01) higher than the birth weight of crossbred bulls which is also supported in Banik (2001) work on birth weight for Murrah bulls. The average three months body weight of crossbred bulls was estimated as 59.38±1.33 kg which was significantly (P<0.01) lower than that of Murrah bulls (62.53±1.05 kg).

The present observations for three months body weight for Murrah bulls was similar to all Murrah animals maintained in NDRI, Karnal and PAU, Ludhiana (Anon , 2002). The average six months body weight of the crossbred bulls was found to be 106.20±1.95 kg. crossbred bulls have significantly (P<0.01) higher six months body weight compared to Murrah bulls (100.88±1.71 kg). Since the phenotypic association between body weights at three months and six months was not significant in Murrah buffalo, these discrepancies between body weight at six months for cattle and buffalo may have arisen. Studies conducted by Pal *et al.* (2004a) have also reported similar findings at all body weight comparisons as reported in this study.

B. Sexual behavioral traits

The observations in respect of various behavioural characteristics under study for crossbred bulls and Murrah bulls are presented in Table 3 and 4.

Libido score

The present study depicted a positive trend of better libido score in crossbred bulls (5.41±0.19) than Murrah buffalo bulls (5.07±0.21). Earlier work has reported libido score ranges from 4.44 to 5.67 in KF bulls (Panwar and Nagpaul, 1989; Adwani *et al.* 1992), whilst similar observations were also reported by studies conducted by Pal *et al.* (2004b), and Pal and Chakravarty, (2004).

Reaction time

Murrah bulls were found to have better reaction time (43.13±5.36) than the crossbred bulls (48.71±6.75). Panwar and Nagpaul (1989) reported the reaction time of KF bulls as 20.8±2.23 sec which was lower than that obtained in present study. This might be due to genotype environmental interaction as the experiments were conducted in two different seasons. Since our present study was conducted during the winter season, libido was expected to be less, hence reaction time was enhanced. Our present study was conducted on randomly allotted bulls, so average reaction time may be a more appropriate measure for comparison. Similar observations to our present study were reported by Pal *et al.* (2004b).

Flehmen's response

Approximately 14.29% ofcrossbred bulls exhibited the Flehmen's response, whereas in Murrah bulls about 65 percent of the bulls had a similar response. Murrah bulls reported a higher Flehmen's response (1.33±0.04) compared to crossbred bulls (1.83±0.39). Panwar and Nagpaul (1989) earlier observed this response in only six percent of the Karan Fries bulls in a small population of KF bulls. Studies conducted by Pal *et al.* (2004b) have also reported similar findings.

Table 1 Libido score card

Sl. No.	Description of libido	Score
1	Bull showed no sexual interest or no mounting	0
2	One mount or mounting attempt, no service	1
3	Two mounts or mounting attempts, no service	2
4	More than two mounts or mounting attempts, no service	3
5	Two mounts one service, followed by sexual interest including mounts and mounting attempts	4
6	More than two mounts or mounting attempts and one service followed by sexual interest	5
7	Two mount one service no further sexual interest	6
8	One mount one service no further sexual interest	7
9	One mount one service followed by sexual interest including mounts or mounting attempts	8
10	More than two mounts and one service, no further sexual interest	9

Table 2 Mean±SE of growth traits of crossbred bulls and Murrah bulls

Species	Birth weight (kg)	3 M Body weight (kg)	6 M Body weight (kg)
Cattle (crossbred bulls)	28.83±0.56[a]	59.38±1.33[a]	106.20±1.95[a]
Buffalo (Murrah)	33.83±0.45[b]	62.53±1.05[b]	100.88±1.71[b]

The means within the same column with at least one common letter, do not have significant difference (P>0.01).

Table 3 Behavioural characteristics of crossbred bulls and Murrah bulls (Mean±SE)

Species	Libido score (Score)	Reaction time (Second)	Flehmen's response (Score)	Mounting stimulus (Score)
Cattle (crossbred bulls)	5.41±0.19	48.71±6.75	1.83±0.39	1.62±0.04[a]
Buffalo (Murrah)	5.07±0.21	43.13±5.36	1.33±0.04	1.25±0.04[b]

The means within the same column with at least one common letter, do not have significant difference (P>0.01).

Table 4 Percent of behavioural characteristics shown by crossbred bulls and Murrah bulls

Species	Flehmen's response (%)	Mounting stimulus (%)
Cattle (crossbred bulls)	14.29	33.33
Buffalo (Murrah)	65.00	72.22

Mounting stimulus

In the present study, crossbred bulls were found to be better as they require less mounting stimuli (score as 1.62±0.04) and only 33.33% of the individuals investigated required any kind of external stimulus for mounting. However, in Murrah bulls about 72.22% (score as 1.25±0.04) of bulls required an external stimulus for mounting, indicating that crossbred bulls were significantly (P<0.01) better than Murrah bulls in terms of mounting stimulus required under the present study (Tables 3 and 4). Panwar and Nagpaul (1989) had also observed for the requirement mounting stimulus in KF bulls.

Similar observations as in present study were reported by Pal *et al.* (2004b).

C. Semen traits

The observations regarding the semen characteristics under study for crossbred bulls and Murrah are presented in Table 5 and 6.

Semen volume

Lowered semen volume (2.70±0.22 mL) was observed in Murrah bulls compared to crossbred bulls (3.86±0.11 mL). The reason for differences in semen volume in both Murrah and crossbred bulls need to be explored in future research. Studies conducted by Pal *et al.* (2006) have also reported similar findings.

Semen consistency

Approximately 22.73%, 40.91%, 31.82% and 4.55% of the crossbred bulls donated creamy, lemon, milky and watery semen. However in Murrah bulls a different trend was observed as 50.00%, 40.00% and 10.00% of the individuals donated creamy, lemon, milky types, respectively. Ninety percent of the Murrah bulls donated better semen in terms of semen consistency and none of the bulls donated watery semen (Table 6). Panwar and Nagpaul (1989) found that KF bulls donated semen of 41%, 54% and 6% as creamy, milk and watery type, respectively. Similar observations to the present study were reported by Pal *et al.* (2006).

Sperm mass activity

Higher semen mass activity (2.10±0.06) was obtained in Murrah bulls as compared to crossbred bulls (1.99±0.07) in the present study (Table 5). Similar observations were reported by Pal *et al.* (2006).

Individual motility of fresh sperm

Individual motility of fresh sperm in crossbred bulls was estimated as 40.73±2.3% and estimated in score as 2.41±0.14 (Table 5). Murrah bulls individual motility of sperm was found to be significantly (P<0.01) higher (58.40±4.15% or 2.41±0.30 in scores) than that of crossbred bulls, which might be due to the variability observed

Table 5 Semen characteristics of crossbred bulls and Murrah bulls (Mean±SE)

Species	Semen volume (mL)	Mass activity (0-5)	Individual motility (%)	Individual motility (Score)	Post-thaw motility (%)	Post-thaw motility (Score)	Semen doses per collection (No.)
Cattle (crossbred bulls)	3.86±0.11	1.99±0.07	40.73±2.3[a]	2.41±0.14[a]	35.43±1.08[a]	2.11±0.08[a]	182.28±6.81
Buffalo (Murrah)	2.70±0.22	2.10±0.06	58.40±1.96[b]	3.18±0.10[b]	44.98±0.77[b]	2.80±0.04[b]	133.59±4.71

The means within the same column with at least one common letter, do not have significant difference (P>0.01).

Table 6 Semen consistency of cattle and buffalo

Species	Semen Consistency (%)			
	Creamy	Lemon	Milky	Watery
Cattle (crossbred bulls)	22.73[a]	40.91[b]	31.82[c]	4.55[d]
Buffalo (Murrah)	50.00[a]	40.00[b]	10.00[c]	-

The means within the same column with at least one common letter, do not have significant difference (P>0.01).

in two different species. Studies conducted by Pal *et al.* (2006) have also reported similar findings.

Post-thaw sperm motility

Significantly (P<0.01) higher post-thaw motility (44.98±0.77%) was observed (Table 5) in Murrah bulls compared to crossbred bulls (35.43±1.08%) which might be due to the species specificity of the buffaloes or due to the different expression of the trait as a result of genotype-environmental interactions. Similar observations as in present study were reported by Pal *et al.* (2006).

D. Averages of milk production traits

a. Expected predicted difference and superiority (%) over the herd average

In the present study, a tendency was observed for the crossbred bulls to have higher EPD (250.00±21.81 kg) compared to Murrah bulls (242.52±12.35 kg). Crossbred bulls having higher superiority (7.72±0.67%) over the herd average whereas Murrah bulls were reported to have 11.03± 0.56% over herd average (Table 7). Anonymous (1999) reported the genetic superiority of bulls, where 17.5 percent of the crossbred bulls showed genetic superiority of 10 percent of the herd average. Studies conducted by Pal *et al.* (2005) have also reported similar findings.

II. Phenotypic associations among various economic traits: The phenotypic association of various phenotypic traits in crossbred bulls and Murrah bulls is presented in Tables 8 and 9, respectively.

Association among growth traits

Association studies of Growth Traits in crossbred bulls revealed that the association of birth weight with three months and six months body weights were high at a signifycant level (P<0.05) and three months with six weight was also found to be highly associated (P<0.01).

The present observation was found to be similar to that of Demeke *et al.* (2003), where high genetic correlation was observed between birth weight and weaning weight, pre-weaning average daily gain and yearling weight as well as among weaning weight, pre-weaning average daily gain and yearling weight.

Table 7 Production traits of crossbred bulls and Murrah bulls (Mean±SE)

Species	EPD (kg)	Superiority (%)
Cattle (crossbred bulls)	250.00±21.81	7.72±0.67
Buffalo (Murrah)	242.52±12.35	11.03±0.56

For the Murrah bulls, the birth weight was significantly associated with three months body weight, and the three months and six months body weight was although highly associated but not found to be significant (Table 9).

Association among various growth and behavioural traits

Association among various growth and behavioural traits depicted that for crossbred bulls, the association of growth traits with libido score and reaction time was found to be low to medium, whereas the trend was low in Murrah bulls. Meyer *et al.* (1991) also reported that serving capacity and weights were phenotypically unrelated for Australian Zebu cattle.

Association of the growth characters with various semen characteristics

For crossbred bulls, the association of the growth characters with various semen characteristics were estimated and observed as mostly low to medium, and high for some characteristics.

However, a high association of the traits was not found to be significant. Susan *et al.* (1984) observed that semen traits were lowly correlated phenotypically with growth traits (–0.08 to 0.08) and genetic correlation estimates were variable.

Table 8 Phenotypic association of various traits in crossbred bulls

	BWT	EPD	LS	RT	SVOL	SCONS	MACT	IMOTF	IMOTPT	SDOSE	X_3	X_6
BWT	1.00											
EPD	0.55± 0.12	1.00	-	-	-	-	-	-	-	-	-	-
LS	0.36± 0.14	0.16± 0.15	1.00	-	-	-	-	-	-	-	-	-
RT	0.14± 0.15	0.29± 0.14	-0.08± 0.21	1.00	-	-	-	-	-	-	-	-
SVOL	0.05± 0.15	-0.37± 0.14	0.29± 0.14	0.02± 0.15	1.00	-	-	-	-	-	-	-
SCONS	-0.36± 0.14	-0.23± 0.15	0.01± 0.15	-0.37± 0.14	0.26± 0.15	1.00	-	-	-	-	-	-
MACT	0.12± 0.15	0.31± 0.14	-0.22± 0.15	0.19± 0.15	-0.17± 0.15	-0.33± 0.14	1.00	-	-	-	-	-
IMOTF	0.47± 0.13	0.43± 0.13	0.11± 0.15	0.49± 0.13	0.11± 0.15	-0.25± 0.15	0.26± 0.15	1.00	-	-	-	-
IMOTPT	0.01± 0.15	0.09± 0.15	0.15± 0.15	-0.26± 0.15	-0.38± 0.14	0.14± 0.15	-0.50± 0.15	-0.52± 0.13	1.00	-	-	-
SDOSE	0.51± 0.13	0.29± 0.14	0.44± 0.13	0.43± 0.14	0.19± 0.15	0.05± 0.15	-0.01± 0.15	0.63*± 0.12	-0.27± 0.14	1.00	-	-
X_3	0.68*± 0.14	0.66*± 0.11	0.04± 0.15	-0.10± 0.15	0.16± 0.15	-0.29± 0.14	0.12± 0.15	0.37± 0.14	-0.09± 0.15	0.17± 0.15	1.00	-
X_6	0.59*± 0.13	0.53± 0.13	0.30± 0.14	0.11± 0.15	0.27± 0.14	-0.15± 0.15	-0.08± 0.15	0.53± 0.13	-0.08± 0.15	0.22± 0.15	0.84**± 0.08	1.00

BWT: body weight; EPD: expected predicted difference; LS: libido score; RT: reaction time; SVOL: semen volume; SCONS: semen consistency; MACT: mass activity; IMOTF: individual motility (Fresh); IMOTPT: post-thaw motility; SDOSE: semen dose; X_3: three months body weight; X_6: six months body weight.
* P<0.05; ** P<0.01.

Table 9 Phenotypic correlation of various traits of Murrah bulls

	BWT	EPD	LS	RT	SVOL	SCONS	MACT	IMOTF	IMOTPT	SDOSE	X_3	X_6
BWT	1.00	-	-	-	-	-	-	-	-	-	-	-
EPD	0.12± 0.14	1.00	-	-	-	-	-	-	-	-	-	-
LS	-0.06± 0.14	-0.18± 0.14	1.00	-	-	-	-	-	-	-	-	-
RT	-0.01± 0.15	0.01± 0.15	-0.53± 0.12	1.00	-	-	-	-	-	-	-	-
SVOL	0.03± 0.15	0.27± 0.14	0.17± 0.14	0.04± 0.15	1.00	-	-	-	-	-	-	-
SCONS	-0.01± 0.15	-0.18± 0.14	-0.12± 0.14	-0.45± 0.13	0.04± 0.15	1.00	-	-	-	-	-	-
MACT	-0.08± 0.15	-0.39± 0.13	0.03± 0.15	0.24± 0.14	-0.11± 0.14	-0.42± 0.13	1.00	-	-	-	-	-
IMOTF	0.16± 0.14	-0.51± 0.12	0.12± 0.14	-0.26± 0.14	-0.53± 0.12	0.47± 0.13	0.30± 0.14	1.00	-	-	-	-
IMOTPT	0.40± 0.13	-0.05± 0.15	0.18± 0.14	-0.05± 0.15	0.37± 0.13	0.35± 0.13	-0.01± 0.15	0.12± 0.14	1.00	-	-	-
SDOSE	-0.46± 0.13	0.03± 0.15	0.36± 0.14	-0.38± 0.14	0.43± 0.13	0.11± 0.14	0.25± 0.14	0.13± 0.14	0.12± 0.14	1.00	-	-
X_3	0.63*± 0.25	0.25± 0.14	-0.09± 0.15	-0.17± 0.14	-0.26± 0.14	0.39± 0.13	-0.42± 0.13	0.22± 0.14	0.50 ± 0.15	-0.10± 0.14	1.00	-
X_6	0.46± 0.13	0.44± 0.13	0.03± 0.15	0.05± 0.15	0.01± 0.15	-0.43± 0.13	-0.42± 0.13	-0.56± 0.12	0.15± 0.14	-0.09± 0.15	0.49± 0.14	1.00

BWT: body weight; EPD: expected predicted difference; LS: libido score; RT: reaction time; SVOL: semen volume; SCONS: semen consistency; MACT: mass activity; IMOTF: individual motility (Fresh); IMOTPT: post-thaw motility; SDOSE: semen dose; X_3: three months body weight; X_6: six months body weight.

A similar trend was observed for the association of growth traits with semen characteristics of Murrah bulls.

Association of growth traits with milk production traits

Association of Growth Traits with Expected Predicted Difference for crossbred bulls had shown that three months body weight was significantly associated with their expected predicted difference (P<0.05) (Table 8). For Murrah bulls, although the association between growth traits with three and six months body weight was found to be medium to high, the associations were not found to be significant.

Association among reproductive traits

The association of libido score with reaction time was found to be negative, but low to high for both crossbred bulls and Murrah bulls, which indicates that libido of the bulls is high because it is negatively related with the reaction time.

The association of behavioural characteristics (libido score and reaction time) with semen characteristics were mostly low to medium but high for some characteristics, both for crossbred bulls and Murrah bulls with LL genotype. The association of individual motility with member of semen doses per collection reported a strong positive and significant ($P<0.05$) correlation for crossbred bulls. However, the trend was found low for Murrah bulls. Most of the association among the semen characteristics in both the species was found to be low to medium. Susan *et al.* (1984) reported that genetic and phenotypic correlations among semen traits were high and favorable with absolute values ranging between 0.49 and 1.11 in Angus cattle. This difference could be due to breed difference.

Association of reproductive traits with milk production traits

The association of behavioural characteristics with expected predicted difference was reported as low to medium for both crossbred bulls and Murrah bulls. The association of various semen characteristics with expected predicted difference for crossbred bulls and Murrah bulls were mostly medium to high (Tables 8 and 9).

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